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Method for bonding a layer of thermoplastic polymer to the surface of an elastomer

Elastomeric materials are as a rule not thermoplastic and therefore also cannot be welded to thermoplastics. They have to date therefore generally been bonded by adhesive bonding. This is complicated, and owing to the use of solvents, environmentally undesired. Furthermore, some thermoplastics are poorly accessible to adhesive bonding, for example polyethylene.

The invention is concerned especially with the bonding of a thermoplastic polymer layer to the surface of an elastomer. It is the object of the invention to provide a bonding method which manages without an adhesive. The achievement according to the invention consists in the features of claim 1 and preferably those of the subclaims.

The method according to the invention is distinguished by the fact that the thermoplastic layer is pressed onto the surface to be bonded thereto while the latter is heated by heat radiation, in particular infrared radiation. This is introduced by irradiation through the thermoplastic layer, which is transparent to these waves, whereas it is absorbed by the surface of the elastomer. Substantially only the surface of the elastomer is heated thereby. The surface of the thermoplastic layer which is pressed against said elastomer is then also indirectly heated by heat conduction. It becomes molten and in this state bonds intimately with the surface of the elastomer.

It is true that it is known (EP-B-0751865, DE-A-3621030, EP-A-159169, EP-A-483569, US-A-5279693, FR-A-1506163, WO 89/10832) that two thermoplastic parts can be bonded by means of laser beams for which the upper of the two parts is transparent and which are absorbed in the region of the weld joint. As a result of the absorption in a thermoplastic material, the latter becomes molten and is therefore directly capable of effecting welding to the counter-surface. If, on the other hand, an elastomer is present instead of the heat-absorbing thermoplastic, heat is generated in the surface of the elastomeric material, which does not become liquid. From there, it flows mainly into the elastomer cross section present behind the surface. Experience to date shows that a

proper bond between a thermoplastic transparent to the radiation and an elastomer absorbing the radiation therefore cannot be achieved by the known method.

That a good bond is nevertheless established according to the invention is due to the peculiarity that the elastomer is foamed. As a result of this, it has a low thermal conductivity, and the heat converted in its surface therefore cannot flow away rapidly toward the back. The surface of the elastomer can therefore be heated to such an extent that the surface of the thermoplastic layer which is pressed against it is sufficiently liquefied by heat conduction to be able to form an adequate bond to the surface of the elastomer. In order to achieve this effect, the thermal conductivity of the elastomer directly behind its surface (i.e. at a distance from the surface which is not greater than 0.5 mm, preferably not greater than 0.2 mm) is expediently less than 0.2 and more preferably less than 0.13 W/mK.

The use of laser light in a visible and invisible range, for example having a wavelength of 1064 nm, is particularly suitable.

It is true that the invention is also applicable when the surface of the elastomer is formed by a closed skin. However, an open-pore surface is preferred, i.e. the porosity of the elastomer extends into the surface thereof. Firstly, this even more greatly inhibits the removal of heat from the surface region. Secondly, it gives rise to the possibility that parts of the thermoplastic which has become molten on the elastomer surface are pressed into the pores under pressure and are anchored therein. This gives an outstanding bond.

To enable a sufficient quantity of heat to be released by the directly heated elastomer surface to the thermoplastic surface to be liquefied, the elastomer surface must be heated substantially higher than is the case for the welding of two thermoplastics. It is therefore expedient to use an elastomer which can be heated briefly to a temperature of at least 30°C above the melting point of the thermoplastic paired therewith, without substantial damage to the bond strength.

Suitable thermoplastics are, for example, polyamide (PA), polybutylene terephthalate (PBT), acrylonitrile-butadiene-styrene (ABS). The melting point may be about 250°C.

Suitable elastomers are, for example, chloroprene rubber, styrene-butadiene rubber (SBR), nitrile-butadiene rubber (NBR), butyl rubber (IIRCIIR, BIIR). If the density of the foamed material is from about 150 to 210 kg/m^3, preferably about 180 kg/m^3, thermal conductivity is generally sufficiently low, namely about 0.1 W/mK. The softening temperature is expediently above 300°C and the decomposition temperature above 350°C.

The method was successfully carried out, for example, as follows. A polyamide film having a thickness of 0.5 mm, a melting point of about 260°C and laser transparency at a wavelength of 1064 nm was pressed with a pressure of from 3 to 5 N/mm^2 onto a layer of chloroprene rubber. An Nd-YAG laser having a wavelength of 1064 nm and 150 W was used for heating. After cooling of the relevant area, it was found that the parts had bonded to one another with outstanding quality.

Other lasers, for example diode lasers, fiber lasers or disk lasers, can also be used.